Evaluation of an Epson flat bed scanner to read Gafchromic EBT films for radiation dosimetry

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INTRODUCTION

Gafchromic EBT (G-EBT) films are becoming increasingly popular due to their advantageous properties. When flat bed colour scanners are used for dosimetry a good quality control of the scanning device is a crucial step for accurate results. The proposal of this work is to fully assess the performance of the scanner Epson Expression 10000XL in order to quantify all parameters and needed corrections to minimize dose uncertainties.

METHODS AND MATERIALS

THE SCANNER

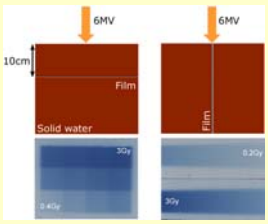
Epson Expression 10000XL

SCANNER LINEARITY

A standard step tablet with 32 steps and optical densities that range from 0.06-3.8 was used.

FILM CALIBRATION

All scans were performed in transmission mode and in portrait orientation in the same region of the scanner. The red colour channel was extracted from the images to maximize film sensitivity. A polynomial expression was used to convert netOD into dose and to quantify the dose uncertainty through error propagation analysis (Devic *et al* Med. Phys. 2005).



Perpendicular calib. Parallel calib.

REPRODUCIBILITY

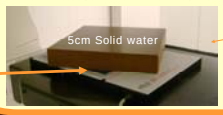
The scanner warming up effect and reproducibility were evaluated by performing 30 consecutive scans followed by 20 scans made with a 15 minutes interval to allow the lamp to cool down.

OPTIMAL SCANNER READING PARAMETERS TESTED

Colour modes: 24 and 48 bits;
Resolutions: 50, 75, 150 and 300dpi;
Number of scans per image: 1, 2, 4, 8 and 16;
Wiener filter: 0 (no filter), 3 and 5 pixels regions.

SCANNER REGION CORRECTION

5 films were irradiated with field sizes of 26x26cm2 at 5cm depth with doses that ranged from 0.5-3.5Gy. A correction was applied to these films to correct for field inhomogeneity using the measurements of a 2D-array seven29 (PTW Freiburg).



CONCLUSIONS

A protocol to read G-EBT films using the Epson Expression 10000XL scanner was established:

- Colour depth: 48 bits extracting the red colour channel,
- Resolution: 75dpi,
- Number of scans: 4,
- Wiener filter: 3x3 pixels,
- Scanner region correction.

The contribution to the overall uncertainty in film dosimetry coming from the scanning process was estimated to be smaller than 2% for doses higher than 0.5Gy. The overall uncertainty was either 1% or 2% depending on the calibration film orientation.

AKNOWLEDGMENTS

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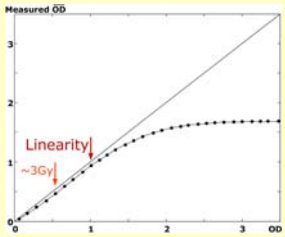
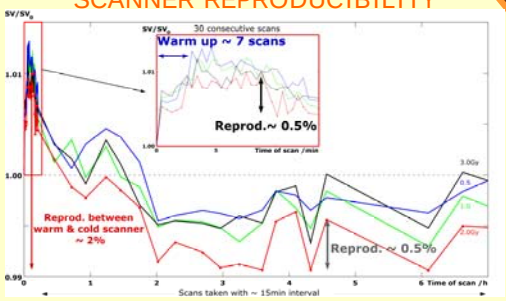
RESULTS AND DISCUSSION

SCANNER LINEARITY



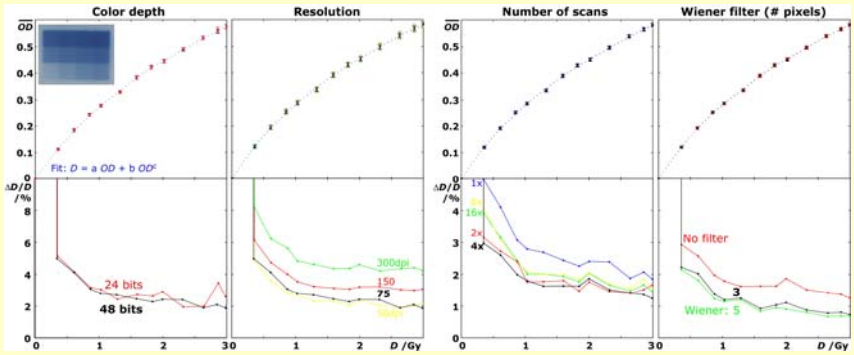
The scanner response was linear until an optical density of 1 which is below doses of clinical interest for G-EBT films.

SCANNER REPRODUCIBILITY



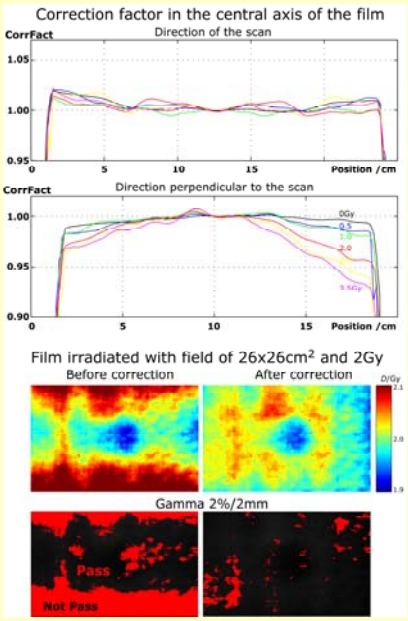
The scanner signal stabilized after 7 readings. A reproducibility around 0.5% was obtained either with the scanner lamp warm or cold. However, mixing readings with the scanner in different states should be avoided.

OPTIMAL SCANNER READING PARAMETERS



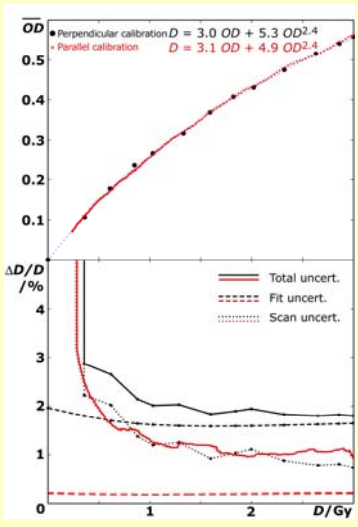
The cumulative choice of optimal scanning parameters: 48bit colour depth, a 75dpi resolution, repeating the scan four times and applying a Wiener filter to a 3x3 pixel region reduced the scanner uncertainty to values below 2% for doses higher than 0.5Gy. For doses higher than 1Gy the uncertainty is reduced to 1%.

SCANNER REGION CORRECTION



Although the most important correction is perpendicularly to the scan direction, a 2D correction must be performed.

FILM CALIBRATION



The orientation of the calibration film doesn't have a significant effect on the shape of the calibration curve, but has an impact on the overall uncertainty due to the smaller fit uncertainty for a parallel calibration. Thus the overall uncertainty for doses higher than 0.5Gy is around 1% for a parallel calibration whether it rises to 2% for a perpendicular calibration.